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PATENT SPECIFICATION

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(54) SOLAR ENERGY COLLECTOR

71) We, THE BRITISH PETROLEUM COMPANY LIMITED, of Britannic House, Moor Lane, London, EC2Y 9BU, a British Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a solar energy collector of improved efficiency.

Solar energy collectors using a fluid to take away the heat caused by radiation falling on the surface of a collector are well known. However, the use of a flowing fluid as a heat-transfer medium has been found to be inefficient since fluids form boundary layers adjacent to the surface from which heat is absorbed. One important consequence of boundary layers is that the radiation absorbing surface is at a higher temperature than the fluid heat transfer medium. The surface therefore re-radiates a substantial portion of the incident radiation thus seriously limiting the efficiency of the solar heat collector. In an attempt to minimise this problem, the use of liquids of improved conductivity has been proposed. However, the results in this case have been found unsatisfactory and uneconomic.

It has now been found that by using the principle of a heat pipe, the evaporation characteristics of volatile liquids and an absorbent of special surface properties, the performance of such collectors can be improved.

Accordingly, the present invention is a solar energy collector comprising an enclosed system comprising (1) a solar radiation absorbing zone having a solar radiation-transparent wall and containing at least some liquid-absorbent solid material having a boundary surface capable of absorbing solar energy (2) a heat collecting zone for receiving the vapour of an evaporable liquid and having heat exchange means to remove heat from the vapour and so cause condensation thereof and (3) means for allowing vapour to pass from said absorbing zone to said collecting zone and means for feeding liquid back to said absorbing zone.

The device of the present invention can particularly be applied with advantage to "flat-plate" collectors which will convert direct or diffuse sunlight into heat, for temperatures below 200°C.

The solar radiation absorbing zone in the device of the present invention can be, for example, a flat box-form container or panel made of thermally insulating material with a backing for strength and to make it easily attachable to structures, one wall being made transparent to solar radiation energy. The transparent wall suitably has a high transmissivity for solar radiation. The container is at least partially filled with a liquid-absorbant material such as perlite or carbon filled open-celled polymer foam which has a boundary surface capable of absorbing solar radiation. Blackening of the liquid-absorbent material, although not essential, in most cases improves the efficiency of absorption of the solar radiation, and is preferred.

When the solar energy collector is operating the liquid-absorbent material contains an evaporable liquid, chosen from liquids having appropriate characteristics of boiling point, flammability, toxicity, latent heat of vapourisation and stability to heat and light over extended periods. Suitable evaporable liquids that may be used to impregnate the absorbent material include water, methanol, ethanol, methylated spirit, carbon tetrachloride or chloroform.

The solar radiation passing through the transparent wall into the solar radiation absorbing zone falls on and heats the liquid-absorbent material thus evaporating the evaporable liquid. The vapour of the

evaporable liquid then passes into and condenses in the heat collecting zone. The condensation of the vapour transfers the latent heat of evaporation to the heat collecting zone. Provided that a favourable temperature differential is maintained between the solar radiation absorbing zone and the heat exchanger in the heat collecting zone unidirectional movement of the vapour from the absorbing zone to the heat collecting zone continues.

The heat collecting zone may be any suitable container having an inlet for the vapour from the absorbing zone and an outlet for returning the condensed liquid to the absorbing zone, and having heat exchange means for condensing the vapour. These means may, for example, comprise a conventional heat exchange unit connected to a radiator system or hot water tank.

The liquid condensed from the vapour in the heat collecting zone may be returned for re-impregnating the absorbent material in the absorbing zone for instance by means of a low power pump located at a suitable point between the solar radiation absorbing and heat collecting zones. Alternatively, the heat collecting zone may be positioned above the solar radiation absorbing zone and the condensed liquid returned to the absorbing zone by gravity flow. In another system, continuous impregnation of the absorbent material may be ensured by extending the absorbent material as a wick so that it dips into the condensed liquid in the heat collecting zone. The liquid then rises automatically to the absorbing zone by capillary action thus completing the cycle.

The invention is further illustrated with reference to the drawings accompanying the provisional specification which shows a schematic sectional view of the device. In the drawing the solar energy collector comprises an thermally insulated box panel 1 provided with a double glazed cover 2 of high transmissivity to solar radiation. The box panel 1 is partially filled with a layer of perlite 3 which is impregnated with a volatile liquid 5. This unit acts as the solar radiation absorbing zone. The box panel 1 is insulated by a foam lagging 9 and is also provided with a safety valve 7 to prevent build up of excessive vapour pressure. The box panel 1 is connected by means of a pipe to a container 4 which acts as the heat collecting zone and which is provided with heat exchange means 8 and a return pipe to the solar radiation absorbing zone. Solar radiation falling on the collector is absorbed by the layer of perlite and transformed to thermal energy. This causes the liquid 5 to evaporate and the vapour thus produced travels to the heat collecting zone which is maintained by the heat exchange means 8 at a lower temperature than the radiation absorbing zone. This operation condenses the vapour, the latent heat of condensation being given up to the heat exchange means. The liquid 5 is continuously pumped at the desired rate to the liquid-absorbent layer of perlite 3 by means of pump 6 to complete the cycle.

WHAT WE CLAIM IS:

1. A solar energy collector comprising an enclosed system comprising (1) a solar radiation absorbing zone having a solar radiation-transparent wall and containing at least some liquid-absorbent solid material having a boundary surface capable of absorbing solar energy, (2) a heat collecting zone for receiving the vapour of an evaporable liquid and having heat exchange means to remove heat from the vapour and so cause condensation thereof and (3) means for allowing vapour to pass from said absorbing zone to said collecting zone and means for feeding liquid back to said absorbing zone.

2. A solar energy collector as claimed in claim 1 in which the solar radiation absorbing zone is a flat box-form container or panel.

3. A solar energy collector as claimed in Claims 1 and 2 in which the solar radiation absorbing zone is at least partially filled with perlite or carbon filled open-celled polymer foam as the liquid-absorbent material.

4. A solar energy collector as claimed in any of the preceding claims in which the liquid-absorbent material is blackened.

5. A solar energy collector as claimed in any of the preceding claims in which the evaporable liquid is water, methanol, ethanol, methylated spirit, carbon tetrachloride or chloroform.

6. A solar energy collector as claimed in any of the preceding claims wherein the heat exchange means is adapted to be connected to a radiator system or hot water tank.

7. A solar energy collector as claimed in any of the preceding claims wherein the means for feeding liquid back to said absorbing zone comprises a pump.

8. A solar energy collector as claimed in any of the preceding claims 1 to 6, in which the heat collecting zone is positioned above the solar radiation absorbing zone so that the condensed evaporable liquid returns from the collecting zone to the absorbing zone by gravity flow.

9. A solar energy collector as claimed in any of the preceding claims 1 to 6 in which

the liquid-absorbent material extends as a wick from the radiation absorbing zone to the heat collecting zone so that condensed evaporable liquid returns from the collecting zone to the solar radiation absorbing zone by capillary action.

10. A solar energy collector substantially as herein described with reference to the drawing accompanying the Provisional Specification.

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COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.